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Titre :

Title :

IEC 60936-1 : Maritime navigation and radiocommunication equipment and systems - Radar - Part 1: Shipborne radar - Performance requirements - Methods of testing and required test results

Introductory note

The original IEC 936 was published in 1988. Since that time the International Maritime Organisation has expanded its requirements for shipborne radar to include high speed craft, back-up for ECDIS and chart facilities. This revision of IEC 936 has been sub-divided into parts to take account of the above additional requirements. Part 1 has been developed to revise the original IEC 936 and to include a new IMO resolution for shipborne radar. In addition it takes account of, for the first time, the new ITU requirements for spurious emissions from radiodetermination systems.

This CDV is circulated as an English only document; the French version has not been made available within the required two month period

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	**Parallel IEC CDV/CENELEC Enquiry**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – RADAR

Part 1: Shipborne radar - Performance requirements - Methods of testing and required test results

FOREWORD

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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60936-1 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems. The IEC 60936 series replaces IEC 936, in order to reflect the new requirements of the International Maritime Organisation (IMO). This part of the series contains some of the IMO specific requirements.

The text of this standard is based on the following documents:

FDIS	Report on voting
80/XX/FDIS	80/XX/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annexes A, B, C and D form an integral part of this standard.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS - RADAR

Part 1: Shipborne radar - performance requirements - Methods of testing and required test results

1 Scope

This International Standard specifies the minimum performance requirements, methods of testing and required test results for conformance to performance standards not inferior to those required by IMO resolution MSC.64(67) Annex 4 Radar. In addition it takes account of IMO resolution A.694 and is associated with IEC 60945. When a requirement of this standard is different from IEC 60945, the requirement in this standard shall take precedence.

This standard does not include the optional performance requirements for superimposition of selected parts of SENC information. These are specified in IEC 60936-3 – Radar with chart facilities.

All text of this standard, whose wording is identical to that in IMO resolution MSC.64(67) Annex 4 are printed in *italics* and the resolution (abbreviated to - A4) and paragraph numbers are indicated in brackets i.e. (A4/3.3).

2 Normative references

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative documents referred to apply.

IEC 60872-1: 1998, Maritime navigation and radiocommunication equipment and systems - Radar plotting - Part 1: Automatic radar plotting aid (ARPA)

IEC 60872-2: 1998, Maritime navigation and radiocommunication equipment and systems - Radar plotting - Part 2: Automatic tracking aid (ATA)

IEC 60872-3: 199X, Maritime navigation and radiocommunication equipment and systems - Radar plotting - Part 3: Electronic plotting aid (EPA) [1)]

IEC 60945: 1996, Maritime navigation and radiocommunication equipment and systems - General requirements - methods of testing and required test results

IEC 60936-3: 199X, Maritime navigation and radiocommunication equipment and systems - Radar - Part 3: Radar with chart facilities [1)]

IEC 61023: 1998, Maritime navigation and radiocommunication equipment and systems - Marine speed and distance measuring equipment (SDME). Performance requirements - Methods of testing and required test results

IEC 61162-1: 1995, Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners

IEC 61162-2: 1998, Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 2: Single talker and multiple listeners - high-speed transmision

IEC 61209: 1998, Maritime navigation and radiocommunication equipment and systems - Integrated bridge systems (IBS) - Operational and performance requirements - Methods of testing and required test results

ISO 9000 series: 1987, Quality management and quality assurance

IMO A.686: 1991, Code on alarms and indicators, as amended by IMO A.830:1995

IMO A.694 :1991, General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system (GMDSS) and for electronic navigational aids

IMO MSC.64(67) : 1996, Annex 4 - Recommendation on performance standards for radar equipment

IMO A.861: 1997, Performance standards for shipborne Voyage data recorders (VDRs)

[1)] Under development

IMO MSC SN/Circular 197: 1997, Operation of marine radar for SART detection
IMO: 1974, as amended - Safety of Life at Sea Convention (SOLAS) - Chapter II-1
ITU: 1997, Radio Regulations
ITU-RM.824-2: 1995, Technical parameters of radar beacons
ITU-RM.628-3: 1994, Technical parameters of search and rescue radar transponders (SARTs)
ITU RM.1177-1:1997, Techniques of measurement for spurious emissions of radar systems

3 Performance requirements

The radio frequency of operation of the equipment shall at all times be within the limits defined in the Radio Regulations.
The ITU at the World Radio Conference 1997 has modified Appendix S3 of the Radio Regulations to include maximum permitted spurious emission power levels for radiodetermination services. This Appendix S3 references ITU - RM.1177, a recommendation on measurement methods for spurious emissions of radar systems, as guidance for the measurement of the required levels.
ITU-RM.1177 has been used as the basis for the development of annex D, which is a detailed method of measurement for spurious emissions of shipborne radar systems.

3.1 (A4/1) Introduction

In addition to the general requirements contained in resolution A.694 all radar installations shall *comply with the following minimum requirements.*

3.2 (A4/2) General

3.2.1 *The radar equipment* shall *provide an indication, in relation to the ship, of the position of other surface craft and obstructions and of buoys, shorelines and navigational marks in a manner that will assist in navigation and in avoiding collision.*

3.2.2 Quality assurance

The radar shall be designed, produced and documented by companies complying with ISO 9000 series standards as applicable.

3.3 (A4/3.1) Range performance

The operational requirement under normal propagation conditions, when the radar antenna is mounted at a height of 15 m above sea level, is that the equipment shall *in the absence of clutter give a clear indication of:*

3.3.1 (A4/3.1.1) **Coastlines**

At 20 nautical miles when the ground rises to 60 m.

At 7 nautical miles when the ground rises to 6 m.

3.3.2 (A4/3.1.2) **Surface objects**

At 7 nautical miles a ship of 5,000 GT, whatever her aspect.

At 3 nautical miles a small vessel of 10 m in length.

At 2 nautical miles an object such as a navigational buoy with a radar reflector height of 3.5 m *having an effective echoing area of approximately 10 m^2.*

3.4 (A4/3.2) Minimum range

The surface objects specified in 3.3.2 shall *be clearly displayed from a minimum horizontal range of 50 m from the antenna position up to a range of 1 nautical mile, without changing the setting of controls other than the range selector.*
The minimum range is the shortest distance at which, using a mandatory range scale of not more than 1,5 nautical miles, a stationary target ahead is still presented separately from the point representing the antenna position.

3.5 (A4/3.3) Display

3.5.1 (A4/3.3.1) *The equipment* shall *provide, without external magnification, a daylight display with a minimum effective diameter within the bearing scale of not less than:*

3.5.1.1 ((A4/3.3.1.1) *180 mm on ships of 150 GT and more but less than 1000 GT;*

3.5.1.2 (A4/3.3.1.2) *250 mm on ships of 1000 GT and more but less than 10,000 GT;*

3.5.1.3 (A4/3.3.1.3) *340 mm on ships of 10,000 GT and upwards.*

3.5.2 (A4/3.3.2) *The equipment* shall *provide the following set of range scales of display: 0.25, 0.5, 0.75, 1.5, 3, 6, 12 and 24 nautical miles.*

3.5.3 (A4/3.3.3) *Additional larger and smaller range scales may be provided.* These additional range scales shall be either smaller than 0,25 nautical miles or greater than 24 nautical miles.

3.5.4 (A4/3.3.4) *The range scale displayed and the distance between range rings* shall *be clearly indicated at all times.*

3.5.5 (A4/3.3.5) *Within the effective display radar video area, the display* shall *only contain information which pertains to the use of the radar display for navigation or collision avoidance and which has to be displayed there because of its association with a target (e.g. target identifiers, vectors) or because of some other direct relationship with the radar display.*

3.5.6 (A4/3.3.6) *The origin of the range scale (radar video)* shall *start at own ship, be linear and* shall *not be delayed.*

3.5.6.1 Facilities may be provided to adjust the displayed radar origin to compensate for antenna offsets (e.g. to the conning position).

3.5.7 (A4/3.3.7) *Multi-colour displays are permitted but the following requirements* shall *be met:*

3.5.7.1 (A4/3.3.7.1) *target echoes* shall *be displayed by means of the same basic colours and the echo strength* shall *not be displayed in different colours;*

3.5.7.2 (A4/3/3/7/2) *additional information may be shown in different colours.*

3.5.7.3 Day and night colours shall be provided.

3.5.8 (A4/3.3.8) *The radar picture and information* shall *be readable under all ambient light conditions*. There shall be a means to adjust monitor brilliance. *If a light shield is necessary to facilitate operation of the display in high ambient light levels, then means* shall *be provided for its ready attachment and removal.*

3.5.9 (A4/3.3.9, 3.3.10) **Radar with 'chart' facilities**

These IMO requirements address options that are not mandatory. They are not included in this standard, but are included in IEC 60936-3.

3.5.10 (A4/3.3.11) **Frequency band**

The frequency band in use shall *be indicated to the operator* as X-band or S-band as applicable.

3.6 (A4/3.4) Range measurement

3.6.1 (A4/3.4.1) *Electronic fixed range rings* equally spaced from the origin shall *be provided for range measurements as follows:*
3.6.1.1 (A4/3.4.1.1) *on the range scale 0.25, 0.5, 0.75 nautical miles at least two and not more than six range rings* shall *be provided, on each of the other mandatory range scales six range rings* shall *be provided, and*

3.6.1.2 (A4/3.4.1.2) *where off-centred facilities have been provided, additional range rings* shall *be provided at the same range intervals* on the mandatory range scales in 3.5.2.

3.6.1.3 Any number of range rings are allowed on the optional additional range scales.

3.6.2 (A4/3.4.2) *An electronic variable range marker* (VRM) *in the form of a ring* shall *be provided with a numeric readout of range This readout* shall *not display any other data.* Temporary overlaying is permitted within the data fields. *For ranges of less than 1 nautical miles, there* shall *be only one zero before the decimal point. Additional variable range markers* meeting the same requirements *may be provided* in which case separate identifiable read-outs shall be provided.

3.6.3 (A4/3.4.3) *The fixed range rings and the variable range markers* shall *enable the range of an object to be measured with an error not exceeding 1 % of the maximum range of the scale in use, or 30 m, whichever is the greater.*

3.6.4 (A4/3.4.4) *The accuracy* of range rings and range markers shall *be maintained when the display is off-centred.*

3.6.5 (A4/3.4.5) *The thickness of the fixed range rings* shall *not be greater than the maximum permissible thickness of the heading line.*

3.6.6 (A4/3.4.6) *On all range scales, it* shall *be possible to set the variable range marker with the required precision within 5 s in all cases. A range that is set by the user* shall *not change automatically when the range scale is changed.*

3.6.7 It shall be possible to vary the brilliance of the fixed range rings and the variable range markers, and to remove them independently and completely from the display.

3.6.8 Facilities may be provided to adjust the displayed radar origin to compensate for antenna offsets (e.g. to the conning position).

3.7 (A4/3.5) Heading indication (heading line)

3.7.1 (A4/3.5.1) *The heading of the ship* shall *be indicated by a continuous line on the display with a maximum error of not greater than 1 degree. The thickness of the displayed heading line* shall *not be greater than 0.5 degree measured at maximum range at the edge of the radar display*, when the display is centred. *The heading line* shall *extend from the trace origin* (own ship's position) *to the edge of the display.* A bearing scale shall be provided to give an indication of the heading to within an accuracy of $\pm 1^{\circ}$ when the display is centred.

3.7.2 (A4/3.5.2) *Provision* shall *be made to switch off the heading indicator* (heading line) *by a device which cannot be left in the "heading line off" position.*

3.7.3 (A4/3.5.3) *A heading marker* (line or mark) shall *be displayed on the bearing scale.*

3.8 (A4/3.6) Bearing measurement

3.8.1 (A4/3.6.1) *An Electronic Bearing Line (EBL),* shall *be provided with a numeric readout of bearing to obtain within 5 s the bearing of any object whose echo appears on the display.*

3.8.2 (A4/3.6.2) *The EBL* shall *enable the bearing of a target whose echo appears at the edge of the display to be measured with a maximum error* of the radar system, excluding sensor errors, *of not greater than ± 1 degree.*

3.8.3 (A4/3.6.3) *The EBL* shall *be displayed on the screen in such a way that it is clearly distinguishable from the heading indicator. It* shall *not be thicker than the heading indicator.*

3.8.4 (A4/3.6.4) *It* shall *be possible to vary the brilliance of the EBL. This variation may be separate or combined with the intensity of other markers. It* shall *be possible to remove the EBL completely from the screen.*

3.8.5 (A4/3.6.5) *The rotation of the EBL* shall *be possible in both directions continuously or in steps of not more than 0.2* ^{0}.

3.8.6 (A4/3.6.6) *The numeric readout of the bearing of the EBL* shall *be displayed with at least 4 digits including one after the decimal point. The EBL readout* shall *not be used to display any other data.* Temporary overlaying is permitted within the data fields. *There* shall *be a positive identification of whether the bearing indicated is a relative bearing or a true bearing.*

3.8.7 (A4/3.6.7) *A bearing scale around the edge of the display* shall *be provided. Linear or non-linear bearing scales may be provided.* The radar picture shall be within this scale.

3.8.8 (A4/3.6.8) *The bearing scale* shall *have division marks for at least each 5 degrees, with the 5 degree and 10 degree divisions clearly distinguishable from each other. Numbers* shall *clearly identify at least each 30 degree division.*

3.8.9 (A4/3.6.9) *It* shall *be possible to measure the bearing relative to the heading line* in head-up mode *and* true bearings *relative* to *North* in the stabilised modes.

3.8.10 (A4/3.6.11) *It* shall *be possible to move the position of the EBL origin away from the own ship to any desired point on the effective display area. By a fast simple operation it* shall *be possible to move the EBL origin back to own ship's position on the screen. On the EBL, it* shall *be possible to display a variable range marker.*

3.8.11 Additional EBL's meeting the above requirements may be provided, in which case separate identifiable read-outs shall be provided. These may be centred on own ship or off-centred.

3.8.12 (A4/3.6.10) *A minimum of two independent lines of parallel index lines* shall *be provided,* independent of, and clearly distinguishable from, an EBL. They shall also be clearly distinguishable from map lines. They shall be fully adjustable independently in both range and bearing with accuracy defined in 3.6.3 and 3.8.2.

3.9 (A4/3.7) Discrimination

3.9.1 (A4/3.7.1) **Range**

The equipment shall *be capable of displaying as separate indications on a range scale of 1.5 nautical miles* or less, *two small similar* ($10m^2$) *targets* in the absence of clutter *at a range of between 50 % and 100 % of the range scale, and on the same bearing, separated by not more than 40 m in range.*

3.9.1.1 The discrimination shall be maintained when the display is off-centred.

3.9.2 (A4/3.7.2) **Bearing**

The equipment shall *be capable of displaying as separate indications two small similar* ($10m^2$) *targets both situated at the same range between 50 % and 100 % of the 1.5 nautical miles range scale, and separated by not more than 2.5 degrees in bearing.*

3.9.3 Side-lobes

The picture quality shall not be adversely affected by side-lobes.

3.10 (A4/3.8) Roll or pitch

The performance of the equipment shall *be such that when the ship is rolling or pitching up to □ 10 degrees the range performance requirements of 3.3 and 3.4 continue to be met.*

3.11 (A4/3.9) Antenna scan

The scan shall *be clockwise, continuous and automatic through 360 degrees of azimuth. The antenna rotation rate* shall *be not less than 20 rpm. The equipment* shall *start and operate satisfactorily in relative wind speeds of up to 100 knots. Alternative methods of scanning are permitted provided that the performance is not inferior.*

To suppress unwanted indirect reflected echoes in blind arcs, sector blanking of the transmission may be used. The sector blanking shall be clearly indicated on the display.

3.12 (A4/3.10) Azimuth stabilisation

3.12.1 (A4/3.10.1) *Means* shall *be provided to enable the display to be stabilised in azimuth by a gyrocompass, or its equivalent in performance. The accuracy of alignment with the compass transmission shall be within 0.5 degrees with a compass rotation rate of 2 revolutions per minute* ($12\ ^0$/s).

3.12.2 (A4/3.10.2) *The equipment* shall *operate satisfactorily in the head-up unstabilised mode when the azimuth stabilisation is inoperative*. An alarm shall be given within 5 s of this failure.

3.12.2.1 The display shall revert to head-up mode after approximately 1 min of azimuth stabilisation remaining inoperative.

3.12.2.2 Any functional limitations shall be explained in the documentation.

3.12.3 (A4/3.10.3) The *change over from one display mode to the other* shall *be possible within 5 s and* shall *achieve the required bearing accuracy.*

3.13 (A4/3.11) Performance monitoring

3.13.1 (A4/3.11) *Means* shall *be available, while the equipment is used operationally, to determine readily a significant drop in system performance relative to a calibration standard established at the time of installation.* A significant drop in performance shall be an overall reduction of 10 dB or more.

3.13.2 (A4/3.11) Separate *means* shall *be provided to check that the equipment is correctly tuned in the absence of targets.*

3.14 (A4/3.12) Anti-clutter devices

3.14.1 (A4/3.12.1) *Suitable means* shall *be provided for the suppression of unwanted echoes from sea clutter, rain and other forms of precipitation, clouds, and sandstorms and from other radars. It* shall *be possible to adjust manually and continuously the anti-clutter controls. In addition, automatic anti-clutter controls may be provided; however, they* shall *be capable of being switched off.*

3.14.2 Adjustment of anti-clutter controls in small discrete steps shall be regarded as continuous adjustment.

Additionally, adjustment by controls which operate by other than circular movement are acceptable on condition that:

a) if they operate by linear movement they shall be inoperative in the fully left or down position, or
b) if they operate by a pair of push buttons, operation of the left or lower button shall render the device inoperative.

An indication of the operative conditions of the anti-clutter control shall be provided.

3.14.3 (A4/3.12.2) *The operational requirement, when the radar antenna is mounted at a height of 15m above sea level, is that the equipment* shall, *even in the presence of sea clutter, give a clear indication of a standard reflector up to 3.5 nautical miles.*

3.15 (A4/3.13) Operation

3.15.1 (A4/3.13.1) **Availability**

3.15.1.1 *After switching on from cold, the equipment* shall *become* ready to be *fully operational within 4 min.*

3.15.1.2 *A standby condition* shall *be provided from which the equipment can be brought to an operational condition within 15 s.*

3.15.2 (A4/3.13.2) **Controls**

Operational controls shall *be accessible and easy to identify and use. Controls* shall *be identified* (see annex B) *and easy to operate.* (see also IEC 60945).

The equipment shall *be capable of being switched on and off and operated from the master display* control *position.*

It shall *be possible to vary the brilliance of the fixed range rings and the variable range markers and electronic bearing lines and to remove them independently and completely from the display.*

For radars with additional synthetic information (e.g. target identifiers, vectors, navigationa information), means shall *be provided capable of removing this additional information from the screen* by dedicated controls or primary access in an associated menu.

3.16 (A4/3.14) Operation with radar beacons and SARTs

3.16.1 (A4/3.14.1) *Radar* shall *be able to detect and display signals from radar beacons and 9 GHz* (X-band) *radars* shall *also be able to detect and display signals from SARTs.*

3.16.2 (A4/3.14.2) *All radars operating in the 9 GHz band* shall *be capable of operating in a horizontally polarised mode. If other polarisation modes are available there* shall *be a positive indication of their use on the display.*

3.16.3 (A4/3.14.3) *It* shall *be possible to switch off those signal-processing facilities, which might prevent a radar beacon or SART from being shown on the radar display.*

3.16.4 The operator section of the documentation provided by the manufacturer shall include instructions, based on IMO SN/Circular 197, that describe the optimum setting of the radar controls to observe a SART.

3.17 (A4/3.15) Display modes

3.17.1 (A4/3.15.1) *The equipment* shall *be capable of operating in* both *relative and true motion.* In true motion mode, when own ship reaches the offset limit, the display shall automatically reset to the offset limit on the reciprocal heading. Manual resetting shall be provided. The true motion mode shall be available on all range scales between 0,75 nautical miles to 24 nautical miles.

3.17.2 (A4/3.15.2) *The radar origin* shall *be capable of being offset to at least 50 % and not more than 75 % of the radius of the display.*

3.17.3 (A4/3.15.3) *The radar* shall *be capable of sea and ground stabilisation. With sea or ground stabilisation the accuracy and discrimination of the display* shall *be at least equivalent to that required by this performance standard.*

3.17.4 (A4/3.15.4) *Speed and distance measuring equipment (SDME) providing the ship's speed through the water to the radar* shall *be capable of providing the speed in the fore and aft direction* (in the ahead direction).

3.17.5 (A4/3.15.5) *The ground-stabilised input* shall *be two-dimensional. It may be provided from the SDME* where a two-dimensional SDME is fitted, *from an electronic position fixing system, or from radar tracked stationary targets. The speed accuracy* shall *be in accordance with the requirements of* IEC 61023.

3.17.6 (A4/3.15.6) *The* speed (3.17.4, 5 or 7), *type of input* (3.17.5) *and stabilisation* (3.17.3) *in use* shall *be displayed*. For compatibility purposes data used and displayed shall be matching combinations of i.e., SOG/COG or HDG/SPD in the head direction.

3.17.7 (A4/3.15.7) *It* shall *also be possible to input the ship's speed manually from 0 (zero) knots to 30 knots in steps of not more than 0.2 knots.*

3.17.8 (A4/3.15.8) *Provision* shall *be made for manual input of set and drift*. An indication that this provision is applied shall be given. The values shall be accessible.

3.18 (A4/3.16) Interference from magnetic fields

After installation and adjustment on board, the bearing accuracy as prescribed in this performance standard shall *be maintained without further adjustment irrespective of the movement of the ship in the earth's magnetic field.* The effect of external magnetic fields shall be sufficiently restricted to ensure that performance is not affected. Effective means shall be provided for the operator to degauss, or equivalent technique, where applicable, to reduce the observable effect of external magnetic fields.

3.19 (A4/3.17) Radar installation

The radar installation, including the antenna, shall *be in such a manner that the performance of the radar system is not substantially impaired. Guidance on installation* shall *be given in the manufacturer's documentation.*

3.20 (A4/3.18) Failure warnings and status indications

3.20.1 *If there is any detectable reason why the information presented to the operator is invalid, adequate and clear* alarm *(warning)* shall *be given to the operator*. As a minimum clear alarms shall be given to the operator of input failure of: -

.1 Azimuth;
.2 Heading line;
.3 Trigger;
.4 Compass;
.5 SDME;
.6 Electronic position fixing system (EPFS) or invalid;
.7 Radar video.

Picture freeze up (screen data not refreshed) shall not occur when any of the seven events in 3.20.1 occur or when any other additional input to the radar system fails.

3.20.2 A fault which prevents the update of a radar picture shall clear the radar display area, and an appropriate alarm shall be given.

3.20.3 Functions and data that depend on a failed sensor or signal shall be indicated or inhibited.

3.20.4 If the radar is installed as part of an integrated system, containing a centralised alarm capability, suitable interfaces[1] (IEC 61162) shall be provided so that the audio alarm can be suppressed remotely whilst the visual indication remains on the radar. (see also 3.22.2)

[1] Output 1. Radar status (Operational/failed) IEC 61162 - ALR
2. Danger of collision (TCPA/CPA limits) IEC 61162 - ALR / OSD

Input Suppress local 'audible' alarm for radar status only IEC 61162 - ACK

3.20.5 Alarms shall be displayed in the order of occurrence. The acknowledgement shall only acknowledge a single alarm.

3.21 (A4/4) Multiple radar installations

3.21.1 (A4/4.1) *Where two radars are required to be carried they* shall *be so installed that each radar can be operated individually and both can be operated simultaneously without being dependent upon one another.* There shall be an indication of the radar and frequency band selected.

3.21.2 (A4/4.1) *When an emergency source of electrical power is provided in accordance with the appropriate requirements of chapter II-1 of the 1974 SOLAS Convention, both radars* shall *be capable of being operated from this source.*

3.21.3 (A4/4.2) *Where two radars,* or more, *are fitted, inter-switching facilities may be provided to improve the flexibility and availability of the overall radar installation.*

3.21.4 (A4/4.2) *They* shall *be so installed that failure of either radar would not cause the other radar to be adversely affected.*

3.22 (A4/5) Interface

3.22.1 (A4/5.1) *The radar system* shall *be capable of receiving information from equipment such as gyro-compass, speed and distance measurement equipment (SDME) and electronic position fixing systems (EPFS) in accordance with international standards* (IEC 61162). *The source of received information* shall *be capable of being displayed.*

3.22.2 (A4/5.2) *The radar* shall *provide an indication when any input from an external sensor is absent* or invalid. *The radar* shall *also repeat any alarms or status messages concerning the quality of the input data from its external sensors.*

3.22.3 (A4/5.3) *If any radar* serial *outputs are provided they* shall *be in accordance with international standards*. (IEC 61162)

3.22.4 If no suitable IEC 61162 interface is available, another appropriate interface may be used.

3.22.5 The equipment shall be capable of providing a dedicated buffered output for screen video[1] and associated synchronisation signals. A description of the output shall be given in the manufacturer's documentation.

3.22.6 An optional "dead-man's handle" output port facility is permitted as long as such a facility does not affect radar performance.

3.23 (A4/6) Navigational information

The radar display shall *be capable of presenting in graphical form, positions, navigational lines and maps, in addition to the radar information* (see annex C). *It* shall *be possible to adjust these points, lines and maps relative to a geographical reference. The source of the graphical information and the method of geographical referencing* shall *be clearly indicated.*

3.24 (A4/7) Plotting

Plotting facilities selected from the three possible options shall *be provided with the radar as follows:*

3.24.1 (A4/7.1) *Ships which are fitted with an electronic plotting aid* shall *be fitted with an "Electronic Plotting Aid" for manual direct plotting as defined in* IEC 60872-3.

[1] IMO A.861 - 5.4.7

3.24.2 (A4/7.2) *Ships, which are fitted with an auto tracking aid,* shall *be fitted with an "auto tracking aid" as defined in* IEC 60872-2.

3.24.3 (A4/7.3) *Ships, which are fitted with an automatic radar plotting aid,* shall *be fitted with ARPA with a minimum effective diameter of 250 mm. as defined in resolution A.823* and as further defined in IEC 60872-1. *The second radar* shall *be fitted with at least an "auto tracking aid".*
3.24.4 (A4/7.4) *Ships of 10,000 gross tonnage and more* shall *be fitted with ARPAs with a minimum effective diameter of 340 mm as defined in Resolution A.823* and as further defined in IEC 60872-1.

3.24.5 (A4/7.5) **Target trails**

It shall *be possible to display the trails by the radar echoes of targets in the form of synthetic afterglow. The trails may be either relative or true.* In true motion the trails shall be true. *The true trails may be sea or ground stabilised. The trails* shall *be distinguishable from the targets* and shall be capable of being switched off. The length of the trails may be user adjustable and be capable of being reset.

3.25 Standard names - abbreviations and symbols

The standard names, abbreviations and symbols for marine radars defined in annex B, where appropriate, shall be used.

3.26 (A4/8) Ergonomics

3.26.1 (A4/8.1) For the purposes of this standard *the following functions,* shall *be directly accessible and immediately effected* by dedicated controls or primary access in an associated menu:

- *On/off switch*
- Standby
- *Monitor brilliance*
- Contrast
- *Tuning (if manual)*
- *Range selection*
- *Anticlutter rain*
- *Electronic bearing line*
- *Dimmer for panel illumination* (where applicable)
- *Gain*
- *Presentation mode*
- *Anticlutter sea*
- *Variable range marker*
- *Marker (cursor)*
- Acknowledge alarm
- Vector true / relative
- Pulse length

Inappropriate pulse lengths shall be either inhibited or clearly indicated.

These functions may be executed by:

- dedicated controls
- primary access in an associated menu
- alternative solutions which meet the functional requirements

3.26.2 (A4/8.2) *The following functions,* shall *be continuously variable or in small, quasi-analogue steps:*

- *Monitor brilliance*
- *Tuning (if manual)*
- *Anticlutter rain*
- *Electronic bearing line*
- *Anticlutter sea*
- *Variable range marker*
- *Marker (cursor)*
- *Gain*

3.26.3 (A4/8.3) *The settings of the following functions* shall *be readable in all light conditions:*

- *Dimmer for panel illumination*(where applicable)
- *Gain*
- *Anticlutter sea*
- *Monitor brilliance*
- *Tuning (if manual)*
- *Anticlutter rain*

The control of the dimmer and monitor brilliance may be located and adjusted by tactile means.

3.26.4 (A4/8.4) *For the following functions, additional automatic adjustment may be provided. The use of the automatic mode* shall *be indicated to the operator and be capable of being switched off:*

- *Monitor brilliance* - *Gain*
- *Anticlutter rain* - *Anticlutter sea*

3.26.5 (A4/8.5) *If discrete controls are available for the EBL and VRM they* shall *be situated on the left and right hand side respectively.*

3.26.6 Display of information

A clear and logical arrangement of data-fields shall be provided. Temporary overlaying is permitted within the data fields.

3.27 Safety precautions

3.27.1 Radiation from the antenna shall be possible only when the beam is scanning, except that override facilities may be provided for maintenance purposes. The maximum distances from the antenna at which radio frequency radiation levels of 100 W/m^2 and 10 W/m^2 can be expected shall be included in the equipment handbook.

3.27.2 Means shall be provided to prevent scanner rotation for maintenance and other purposes.

4 Methods of testing and required test results

This clause defines the type test methods and results required ensuring that equipment complies with the requirements of 3.

4.1 General conditions of measurement and definitions

All the general requirements of IEC 60945 shall be carried out before tests to verify whether the "Equipment under test" (EUT) meets these technical requirements. The equipment shall comply with those requirements of IEC 60945 appropriate to its category, i.e. 'protected' (from the weather) or 'exposed' (to the weather).

The manufacturer shall declare which equipment or units are ‘protected’ or ‘exposed’. The manufacturer shall declare the ‘preconditioning’ required before environmental checks.

For the purposes of this standard the following definitions shall apply: -

Performance check - reconfiguration of the EUT and checking by non-quantitative visual checks that the system is still operative for the purposes of IEC 60945

Performance test - for radar EUT, shall be identical to the performance check for the purposes of IEC 60945

By inspection - a visual check of the equipment or documentation

Clear indication or visibility of test targets – visible for 50% of the antenna scans

Standard operating mode – in the operational condition defined in 3.15.1.2.

4.1.1 Test site

Tests will normally be carried out at test sites selected by the type test authority. The manufacturer shall, unless otherwise agreed, set up the equipment and ensure that it is operating normally before type testing commences.

4. 1.2 Height of radar antenna

During all appropriate tests, the radar antenna shall be mounted at a height of about 15m above the surface of the water.

4.1.3 Test targets for range performance

Unless otherwise specified the effective echoing area of test targets and the target distances and heights used to determine conformity with this standard shall be referred to a point source target presenting an effective echoing area of 10 m^2 at the relevant frequency, at a height of 3,5 m and at a distance of 2 nautical miles by the method described in annex A.

4.1.4 Sea state

Range performance measurements shall be conducted using a test target in a calm sea (Sea state 0 or 1).

4.1.5 Radio frequency

Where tests relating to the radio frequency are specified, these shall be carried out only at the nominal operating radio frequency of the equipment unless specified otherwise.

4.2 Power supply, cabling distances and technical information

The supply voltage applied to the equipment during the tests shall be the nominal voltage and a.c. supplies be at nominal frequency unless specified otherwise.

4.2.1 Sub-system separation

4.2.1.1 When equipment with separate transmitter and antenna is tested in accordance with this standard, the transmitter / receiver shall be connected to the antenna by 20 m of feeder.

The display shall be connected to other units by 65 m of cable. Where an equipment, in which the transmitter and receiver are always installed within the antenna / pedestal combination, is type tested, the 20 m of antenna feeder shall be omitted. Where necessary the manufacturer shall supply the appropriate cable and antenna feeder.

4.2.1.2 The manufacturer or his representative may propose for consideration by the testing authority the maximum and minimum distances by which units of the equipment must be separated in order to comply with the requirements of this standard.

4.2.2.1 Technical information

Adequate information shall be provided to enable the equipment to be properly set up, maintained and operated during the type testing.

4.3 (3.3) Range performance

4.3.1 Method of measurement

A test target as specified in 4.1.3 and at a minimum distance of 2,0 nautical miles shall be used for this test.

As far as is practicable coastlines and ships shall be observed during the tests.

4.3.2 Results required

The equipment shall give a clear indication of the test target.

Where objects described in 3.3 are included in the test, they shall be clearly indicated on the radar display.

4.4 (3.4) Minimum range

4.4.1 Method of measurement

With the radar adjusted within its specification in such a way that a test target at approximately 1 nautical mile is clearly visible. A second test target shall be moved to approach the radar antenna. The range at which the second test target ceases to be presented separately from the antenna position on the display shall be recorded.

For this measurement the range selector and the sea control only may be adjusted and, after adjustment, the target shall be visible at the minimum range and at 1 nautical mile with the same setting of the sea control.

4.4.2 Results required

The minimum range shall be not greater than 50 m measured horizontally.

4.5 (3.5) Display

4.5.1 (3.5.1) Method of measurement

The effective diameter of the display area shall be determined by linear measurement with a rigid ruler, and range scales and number of range rings provided on each scale shall be examined by visual inspection, while the equipment is operating.

4.5.2 Results required

The effective display diameter shall conform to the requirements of 3.5.1.

4.5.3 (3.5.2-3.5.8/3.5.11) Method of measurement

The requirements shall be checked by inspection during operation of the equipment.

4.5.4 Results required

The equipment shall comply with the requirements of 3.5.2, 3.5.3, 3.5.4, 3.5.5, 3.5.6, 3.5.7, 3.5.8 and 3.5.11.

4.6 (3.6) Range measurement

4.6.1 (3.6.1, 3.6.2, 3.6.4, 3.6.5, and 3.6.7) Method of measurement

The requirements shall be checked by measurement and inspection during operation of the equipment.

4.6.2 Results required

The results shall comply with the requirements.

4.6.3 (3.6.3) Method of measurement

Using the ‘standard operating mode’, the accuracy of the range rings and variable range marker, shall be measured using test targets or other means as appropriate.

4.6.4 Results required

The results shall comply with the requirements of 3.6.3.

4.6.5 (3.6.6) Method of measurement

Using the ‘standard operating mode’, the accuracy of the range rings and variable range marker, shall be measured using test targets or other means as appropriate

4.6.6 Results required

A range measurement shall be capable of being taken within 5 s of switching on a VRM and shall be within ± 0,1 nautical miles or ± 2 % of range scale in use, whichever is the greater.

4.7 (3.7) Heading indicator (heading line)

4.7.1 Method of measurement

The requirements for the heading indication shall be checked by inspection. The thickness of the heading line shall be measured at the edge of the display.

4.7.2 Results required

The heading indication shall comply with the requirements of 3.7.

4.8 (3.8) Bearing measurement

4.8.1(3.8.1,3.8.2) Method of measurement

Using the 'standard operating mode', the overall accuracy of taking bearings by the radar equipment shall be measured by comparing the actual bearings of identifiable point targets with bearings obtained using the radar equipment.

The comparison shall be made at sample bearings distributed over 360 ° .

The distance of each target from the radar antenna shall be between 80 % and 100 % of the range scale in use.

The measurement can be made by: -

a) using a single point target positioned at known bearings relative to the radar antenna pedestal, or

b) taking the radar bearing of point targets at known bearings around the radar antenna pedestal, or

c) using two point targets of angular separation of approximately 45 ° with respect to the radar antenna. The apparent variation in angular separation of the two targets due to rotation of the radar antenna pedestal shall be measured.

4.8.1.1 All means provided by the radar equipment for taking bearings shall be checked.

4.8.2 Conformity with other requirements of 3.8 (except for 3.8.1, 3.8.2 and 3.8.12) shall be checked as appropriate by visual inspection.

4.8.3 Results required

A bearing shall be capable of being taken within 5 s of switching on the EBL and the maximum bearing error shall not exceed ± 1 ° .

4.8.4 Parallel index lines

4.8.4.1 Method of measurement

The presence and operation of parallel index lines shall be checked by inspection.

4.8.4.2 Results required

The parallel index lines shall comply with the requirements of 3.8.12.

4.9 (3.9) Discrimination

4.9.1 (3.9.1) Range discrimination

4.9.1.1 Method of measurement

The radar shall be set to a range scale of 0,75 nautical miles. Two test targets of equal radar cross-section shall be placed on the same bearing with respect to the radar antenna, at a distance of between 0,375 nautical miles and 0,75 nautical miles, and separated from each other by a distance of not more than 40 m. The rain control and the effective pulse length of the radar shall be set to their minimum values. The sea and gain controls shall be adjusted to show separation of the two targets on the display for at least 8 out of 10 antenna scans.

4.9.1.2 Repeat the test with the display off-centred.

4.9.1.3 Results required

The test targets shall be displayed separately on the radar display.

4.9.2 (3.9.2) Bearing discrimination

The test below obviates the need to assess the antenna main beam pattern.

4.9.2.1 Method of measurement

The radar shall be set to the range scale of 1,5 nautical miles. Two test targets of equal radar cross-section shall be placed at the same distance from, and separated in bearing with respect to, the radar antenna. The measurement shall be made at display inter-cardinal points ± 5 ° i.e. 40 ° to 50 °, 130 °to 140 °etc. The distance shall be between 0,5 and 1 nautical mile range.

The rain control of the radar shall be set to its minimum value. The sea and gain controls shall be adjusted to show each of the two targets on the display for at least 8 out of 10 antenna scans. The angular separation between the two targets shall be decreased until they cease to be displayed separately.

4.9.2.2 Results required

The angular separation at which the targets cease to be displayed separately shall not exceed 2,5 °.

4.9.3 (3.9.3) Antenna side-lobes

4.9.3.1 Definitions

1. Antenna horizontal radiation pattern. The antenna horizontal radiation pattern is a graph to show the relative response of the antenna plotted against angular displacement in the horizontal plane.

2. Side-lobe. Any positive excursion from the monotonically decreasing main beam pattern of more than 2 dB.

4.9.3.2 Method of measurement

The horizontal radiation pattern of the radar antenna shall be measured either in the far field region or in a region that can be referenced to it. This shall be carried out at the nominal operating radio frequency of the equipment and also at the upper and lower limits of the radio frequency tolerance declared by the manufacturer.

4.9.3.3 Results required

The far field horizontal radiation pattern shall conform to the following table 1, the figures relating to one-way propagation only:

Table 1 - Effective side-lobes

Position relative to maximum of main beam degrees	**Maximum power relative to maximum of main beam** dB
within ± 10	- 23
outside ± 10	- 30

4.9.4 Compliance for alternative methods of meeting the above requirements may be demonstrated by measurements of antenna radiation pattern and submission of processing methods for achieving the required results.

4.10 (3.10) Roll and pitch performance

This shall be determined by measurement of the vertical radiation pattern together with the results of range performance tests of 4.3.

Alternatively, compliance with the requirements of 3.10 may be demonstrated by tilting the antenna first in the fore/aft axis and then in the port/starboard axis and verifying the test target in 4.1.3 is still detected .

The minimum range requirements of 3.4 are tested by the method of 4.4 without applying roll and pitch.

4.10.1Definition

The antenna vertical radiation pattern is a graph to show the relative response of the antenna plotted against angular displacement in the vertical plane.

4.10.2 Method of measurement

The vertical radiation pattern (one way) of the radar antenna shall be measured either in the far field region or in a region that can be referenced to it. This shall be carried out at the nominal operating frequency of the equipment and also at the upper and lower limits of the radio frequency tolerance declared by the manufacturer.

4.10.3 Results required

Where excess performance of the equipment with respect to the requirements of 3.3 has been determined by the application of attenuation or any other method (e.g. by increasing the range of the test target) in the tests of 4.3.1, the antenna vertical radiation pattern shall be such that any reduction between the response at horizontal and the response in any other direction within ± 10 ° of the horizontal, shall be not more than the measured excess performance.

Where attenuation is applied in only the receive path or the transmit path in the test of 4.3.1 the attenuation figure recorded in 4.3.2 shall be halved. Alternatively, if the test target used in the tests of 4.3.1 gave a clear indication at a distance of not less than 2,8 nautical miles (see annex A), the far field radiation pattern shall be not more than 3 dB down, in any direction within ± 10 ° of the horizontal.

4.11 (3.11) Antenna scan

4.11.1 Method of measurement

The antenna/pedestal combination shall be placed in a wind tunnel capable of producing an air stream of up to 100 knots. The antenna motor shall be provided with a power source at its nominal voltage and frequency.

Where appropriate, only the antenna/pedestal combination shall be used in this test. The rate of scan of the antenna shall be measured for all rotation speeds declared by the manufacturer.

4.11.2 Results required

4.11.2.1 The antenna shall start and run satisfactorily in relative speeds of up to 100 knots.

4.11.2.2 The antenna scan shall be continuous and clockwise when viewed from above and automatic through 360 ° in azimuth, and shall be not less than 20 rpm for all radar range scales.

4.12 (3.12) Azimuth stabilisation

4.12.1 Method of measurement

The output from a compass, or compass simulator, shall be applied to the radar. The heading change shall be applied in a clockwise direction and shall increase from 0 °/s to 12°/s in approximately 3 s.

The rotation rate of 12°/s shall be applied for at least 60 s and shall be stopped after an appearance of the heading line. At the next appearance of the heading line the error in alignment in degrees shall be recorded.

The measurement shall be repeated by applying the heading change in an anti-clockwise direction.

4.12.1.2 The requirements of 3.12.2 and 3.12.3 shall be checked.

4.12.2 Results required

4.12.2.1 The alignment error shall not exceed 0.5 °.

4.12.2.2 Changeover from one presentation mode to another (e.g. north-up to head-up) shall be possible with an accuracy of 0.5 ° within 5 s. The equipment shall continue to operate satisfactorily in the unstabilised mode when the compass input is inoperative. The documentation shall be checked for the inclusion of functional limitations.

4.13 (3.13.1) Performance monitor check

4. 13. 1 Method of measurement

The overall radar performance shall be reduced by 10 dB using a method appropriate to the equipment under test.

4.13.2 Results required

It shall be possible to identify an overall reduction in performance of 10 dB or more.

4.13.3 (3.13.2) Tuning

Confirm by inspection that there is a means to check that the equipment is correctly tuned in the absence of targets.

4.14 (3.14) Anti-clutter devices

4.14.1 (3.14.1, 3.14.2) Method of measurement

The requirements for anti-clutter devices shall be checked by inspection during operation of the equipment. If an automatic anti-clutter option is provided, the equipment shall be tested in both manual and automatic modes.

4.14.2 Results required

The equipment shall comply with the requirements of 3.14. The documentation shall be checked to show that adequate explanation of the controls is included.

4.14.3 (3.14.3) Test conditions (range performance in sea clutter)

A test target of 100 m^2 at X-band shall be provided. The reduced radar cross section at S-band is offset by a corresponding reduction in clutter. The test target shall be set at 3.5 m height, together with a radar antenna height of 15 m.

4.14.4 Method of measurement

1. Observe that the clutter field extends to, at least, 2 nautical miles for X-band and 1 nautical mile for S-band;
2. Ensure that the target within the clutter field is initially obscured with the anti-clutter control off;
3. Adjust the anti-clutter control to obtain a clear indication of the target;
4. Repeat the measurements at 4.14.4.1 and 4.14.4.2 at, at least, three ranges, approximately equally spread between 100 m and the extent of the clutter field which may be up to a maximum of 3,5 nautical miles.

4.14.5 Automatic anti-clutter

Repeat 4.14 within the limitations explained in the manufacturer's operating manual.

4.14.6 Equivalent methods using a simulator are permitted.

4.14.7 Results required

A 'clear indication' of the test target in accordance with 4.1.5.

4.15 (3.15) Operation

4.15.1Method of measurement

The requirements of 3.15 shall be checked by inspection, and use shall be made of each external control function during the testing of the equipment.

4.15.2 Results required

The equipment shall comply with the stated requirements.

4.16 (3.16) Operation with radar beacons and SARTs

4.16.1 The requirements of 3.16.1 to 3.16.3 shall be checked during operation of the equipment. Check by both operation and inspection of documentation that the radar is compatible with ITU-RM.824 (Radar beacons) and ITU-RM.628 (SARTs).

4.16.2 Check that the operation with radar beacons and SARTs are included in the operator's section of the manufacturer's documentation.

4.16.3 Results required

The equipment and manual shall comply with the requirements of 3.16.

4.17 (3.17) Display modes

4.17.1 (3.17) By inspection.

4.17.2 (3.17.2) By inspection.

4.17.3 (3.17.3) Method of measurement

Repeat the tests of 4.3, 4.4, 4.6, 4.8 and 4.9 with the alternative stabilisation applied.

4.17.4 (3.17.4, 3.17.5) No test required.

4.17.5 (3.17.6, 3.17.7 and 3.17.8) By inspection.

4.18 (3.18) Interference from external magnetic fields

4.18.1Method of measurement

The requirements of 3.18 shall be checked, as far as practicable, by visual inspection and during operation of the equipment.

4.18.2 Results required

The equipment shall comply with the requirements of 3.18, and the bearing accuracy of the equipment, as prescribed in the requirements of 3.18.1, shall be maintained without further adjustment irrespective of the movement of the equipment in the earth's magnetic field.

4.19 (3.19) Radar installation

4.19.1Results required

Verify that installation guidance is given in the manufacturer’s documentation.

4.20 (3.20) Failure warnings and status indications

4.20.1 Method of measurement

Reproduce the failures defined in 3.20.1

4.20.2 Results required

Verify that appropriate warnings are given and that picture freeze up does not occur.

4.21 (3.21) Multiple radar installations

Where inter-switching facilities are provided they shall comply with the requirements of 3.21.2.

4.22 (3.22) Interface

4.22.1Method of measurement

Simulate the input signals on the IEC 61162 interface from gyrocompass, SDME and EPFS equipment using HDT for gyrocompass, VBW for SDME and GLL, GLC for position.

4.22.2 Results required

Check that:

1. the readouts (displayed data) match the simulated values,

2. the status data is repeated,

3. when input data is removed an alarm or indication results,

4. the source of information is displayed.

4.22.3 (3.22.3) Check by inspection.

4.22.4 (3.22.4) Confirm that details of any other outputs are given in the manufacturer’s documentation.

4.22.5(3.22.5) Confirm the availability of a video output by connection of a compatible monitor. Confirm that a fault in the monitor does not interfere with the operation of the radar. Confirm that the manufacturer's documentation provides information on the video output.

4.23 (3.23) Navigational information

4.23.1Method of measurement

Enter a minimum of three way-points visible on the current range scale.

4.23.2 Results required

Confirm that the way-points appear in the correct positions. If more than one source is available, confirm that the source is indicated.

Check, for compliance, the means of positioning of radar maps and conformity to annex C.

Confirm that the methods of "geographic referencing" are clearly indicated.

Confirm any other feature, as described in the manufacturer's documentation, operates as described.

4.24 (3.24) Plotting

4.24.1 The manufacturer shall declare for which types of plotting facilities (3.24.1 to 3.24.4) the equipment is designed.

4.24.2 Methods of measurement and results required

Refer to IEC 60872-1, IEC 60872-2, or IEC 60872-3, as appropriate.

4.24.3 (3.24.5) Target trails

Check the functionality, for compliance, by inspection.

4.25 (3.25) Standard names, abbreviations and symbols

By inspection.

4.26 (3.26) Ergonomics

4.26.1Method of measurement

With the EUT in operation, checks shall be carried out.

4.26.2 Results required

Check that the functions in 3.26.1 to 3.26.6 can be met.

4.27 (3.27) Safety precautions

4.27.1Method of measurement

The radar equipment shall be set to operate in the condition that gives maximum mean radiated power from the antenna unit, having due regard to pulse duration and pulse repetition as may be determined by the range scale in use.

Stop the antenna scanning for the duration of this test while microwave power is being transmitted. A search for the power density levels in 3.27 shall be carried out in the vicinity of the antenna by means of a radio-frequency radiation monitoring instrument appropriate to the frequency range in use.

4.27.2 Results required

The maximum distance from the scanner of the antenna, within which a power density of 100 W/m^2 is exceeded shall be recorded. The maximum distance within which one tenth of this power density is measured shall also be recorded.

4.28(3) Spurious emissions

4.28.1Method of measurement

See annex D.

4.28.2 Results required

The levels shall be as in Table II of Appendix S3 of the Radio Regulations, for the radiodetermination service.

ANNEX A
(normative)

Method for relating the radar cross-section (echoing area) of one radar target with another

A.1 Effect of a change of target size

Where a target of radar cross-section or "echoing area " σ_1 is substituted for σ_2 in the same circumstances, the corresponding change in power from p_2 to p_1 received back at the radar is given by:

$$p_1/p_2 = \sigma_1/\sigma_2 \quad (1)$$

Hence $$10 \log (p_1/p_2) = 10 \log (\sigma_1/\sigma_2) \text{ dB} \quad (2)$$

Example 1: When a 30 m^2 radar reflector is substituted for 10 m^2 ,the change in power received back at the radar will be:

$$10 \log (30/10) = 4{,}8 \text{ dB}$$

A.2 Effect of a change of distance ("range")

Apart from other possible effects described in subsequent clauses, the relationship between power p_1 reflected back from a target at distance d_1, and power p_2 reflected back from the same target at distance d_2, is given by the inverse fourth power law as:

$$\frac{p_2}{p_1} = \frac{d_1^{\,4}}{d_2^{\,4}} \quad (3)$$

In decibels, equation (3) becomes: $$10 \log (p_2/p_1) = - 40 \log (d_2/d_1) \text{ dB} \quad (4)$$

Example 2: A change of distance from 2 nautical miles to 3 nautical miles will give, apart from other possible changes described below, a power change of:

$$- 40 \log (3/2) = -7{,}0 \text{ dB}$$

A.3 Effect of target height and radar height on discrete (non-distributed) targets ("lobing")

In calm to moderate sea states, a radar wave train that is reflected from the sea surface (with the angle of incidence equal to the angle of reflection) before striking the target will add vectorially with the wave train that travels directly to the target. This vectorial addition gives rise to a power enhancement Y seen at the radar. When Y is expressed in decibels it can vary between the limits + 12 dB and - ∞ dB. This is of considerable importance when "discrete" or "point source" targets are used.

For the 3 cm band (9 410 MHz) and for the 10 cm band (3 050 MHz) values for the enhancement Y (in decibels) can be read from figures A.1 and A.2. The formulae on which the values in figures A.1 and A.2 are based are given in A.6.

Example 3:

Question: Referring to an X-band radar whose antenna height above the sea is 15 m, at what height above the sea must a physically small 10 m^2 target be mounted, at a distance of 2 nautical miles, in order to give a net effect of 10 m^2 at this distance?

Answer: This will be the condition where enhancement Y = 0 dB.
By inspection of the curve for 9 410 MHz in figure A.1, the minimum such height is 0,7m.

A.4 Effects of frequency sensitivity

Certain types of target are frequency sensitive, as will be indicated in the formula relating the physical dimensions of the particular device to its radar cross-section. For a trihedral corner reflector the radar cross section varies as the square of frequency.

For example, the performance of a trihedral corner reflector will be reduced by 9,9 dB at S-band compared with X-band. It must be borne in mind also that a change of operating frequency will affect in addition the considerations described in A.3 above.

A.5 Conclusion

Factors that affect the performance of given radar targets under normal propagation conditions are described above. This gives a theoretical method whereby one target may be compared with another, by simple addition of the various factors expressed in decibels.

Example 4:

Question: It is calculated from the dimensions of a particular corner reflector that its radar cross-section (echoing area) is 30 m^2 (in free space) at a frequency of 9 410 MHz (X-band). This reflector is mounted at a height of 2,5 m above sea level, at a distance of 3 nautical miles from a radar antenna mounted at a height of 15 m and operating at X-band.

How might the power returned to the radar from this reflector be expected to compare with that from a 10 m^2 target situated at 2 nautical miles from the radar at a height of 0,7 m (as used in example 3)?

Answer: Considering the various relevant factors:

a)	power change due to greater target size is 10 log (30/10)	= + 4,8 dB
b)	power change due to greater distance is - 40 log (3/2)	= - 7,0 dB
c)	power change (enhancement) due to lobing at 3 nautical miles is seen by inspection of figure A.1 (9 410 MHz, target height 2.5 m) is	= + 10,7 dB
	Adding the above three factors, the following answer is obtained	+ 8,5 dB

A.6 Formulae for figures A.1 and A.2

$$Y = 16 \sin^4 \frac{4\pi h_1 h_2 f}{2c\ D} \qquad (5)$$

where:

h_1 = radar height) above the tangent plane to the
h_2 = target height) earth at the reflection point.
f = frequency of operation

c = velocity of microwave propagation
D = radar-to-target distance

NOTE - for horizontal polarisation only:

In the case of the curved earth, the heights h_1 and h_2 above the tangent have to be determined from the corresponding heights h_r and h_t of the radar and target respectively above the surface, by use of the approximate relationships (obtained from geometrical considerations):

$$h_1 = h_r - \frac{(h_r\ D)^2}{d\ (h_r + h_t)^2} \qquad (6)$$

and

$$h_2 = h_t - \frac{(h_t\ D)^2}{d\ (h_r + h_t)^2} \qquad (7)$$

where d is the effective diameter of the “radio” earth (taken here as 6 371 x 4/3 x 2 = 16 990 km)

The formulae do not take the influence of “beam divergence” during reflection at the curved earth into account, which will reduce the maximum enhancement and “fill in” the nulls, thus increasing the minimum values of Y above - ∞.

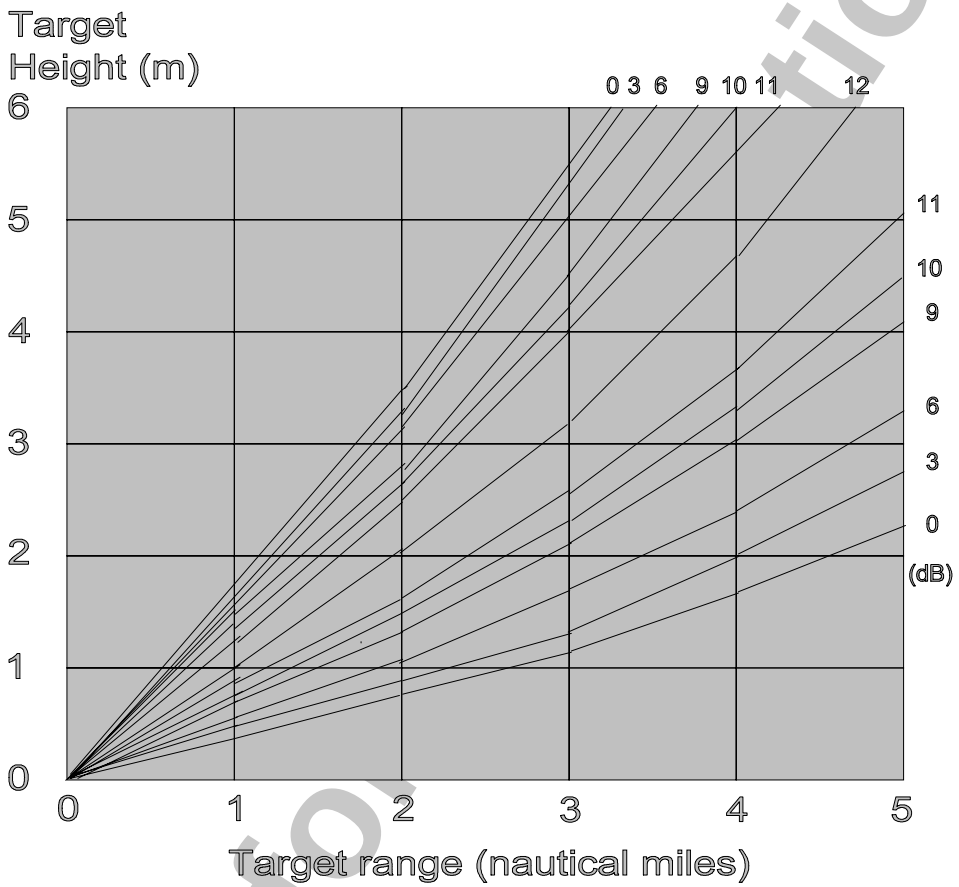


Figure A.1 - Enhancement by reflection (dB) over free-space
Antenna height 15 m - Frequency 9 410 MHz

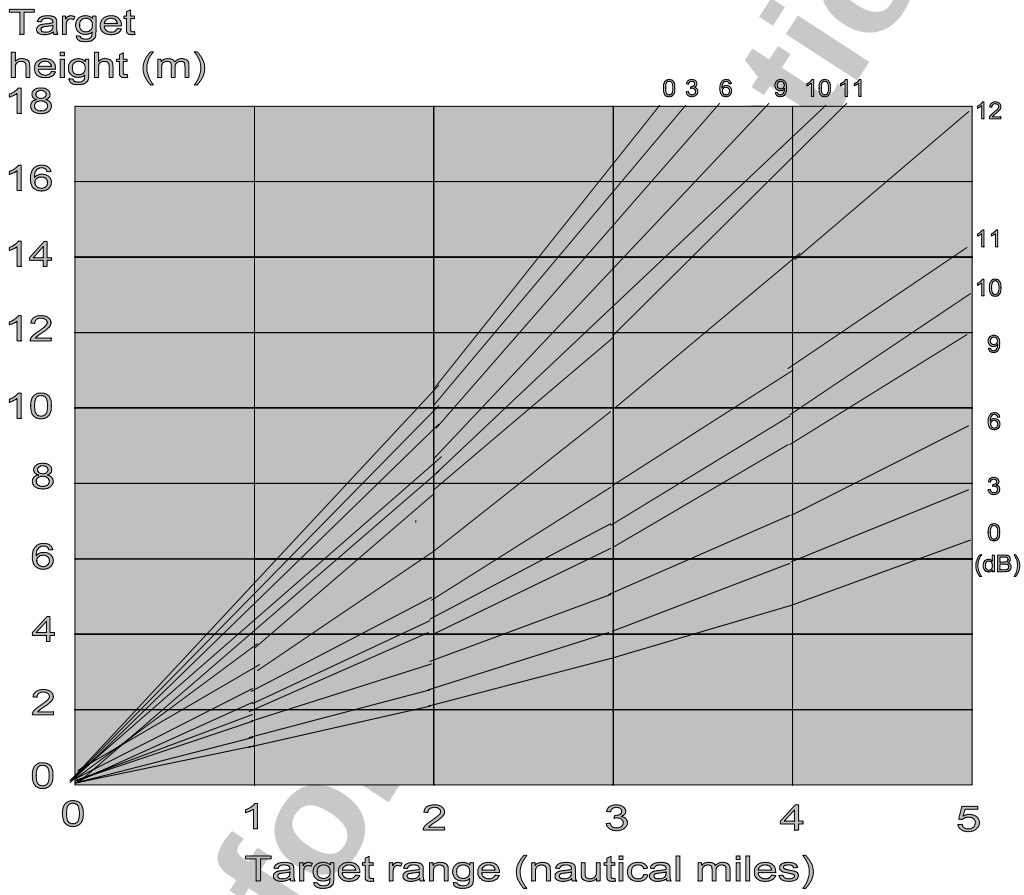


Figure A.2 - Enhancement by reflection (dB) over free-space
Antenna height 15 m - Frequency 3 050 MHz

ANNEX B
(normative)

Standard names, abbreviations and symbols for control functions on marine navigational radar equipment

B.1. List of controls

When any of the following controls are used, they shall be identified in English by the relevant name or abbreviation given in the following list. In addition they may be identified by standard symbols.

STANDARD NAMES	STANDARD ABBREVIATIONS	STANDARD SYMBOLS	DESCRIPTIONS
OFF	OFF	1	Off. e.g. radar or display
ON	ON	2	On. e.g. radar or display
STAND-BY	STBY	3	Standby
NORTH-UP	N UP	4	North stabilised display mode
HEAD-UP	H UP	5	Head-up unstabilized display mode
HEADING LINE OFF	HL OFF	6	Heading line on display to be switched off momentarily
RANGE	RANGE	7	Range scale in use. Plus (+) or minus (-) to indicate range up or down
SHORT PULSE	SP	8	Short pulse
LONG PULSE	LP	9	Long pulse
TUNE	TUNE	10	Tune
GAIN	GAIN	11	Gain of the receiver
RAIN	RAIN	12	Anti-clutter rain
SEA	SEA	13	Anti-clutter sea
PANEL ILLUMINATION	PANEL	14	Display panel brilliance
DISPLAY BRILLIANCE	BRILL	15	Brilliance of the picture on the display
RANGE RINGS	RR	16	Fixed range rings on the display
VARIABLE RANGE MARKER	VRM	17	Variable range marker on the display
ELECTRONIC BEARING LINE	EBL	18	Electronic bearing line on the display
PERFORMANCE MONITOR	PM	19	Performance monitor

B.2 Code of practice for symbols

The following code of practice shall be used when marking radar sets with optional symbols:

B.2.1 The maximum dimension of a symbol shall not be less than 9 mm

B.2.2 The distance between the centres of two adjacent symbols shall be not less than 1.4 times the size of the larger symbol

B.2.3 Switch function symbols shall be linked by a line. A linked line infers controlled action

B.2.4 Variable control function symbols shall be linked by a line, preferably an arc. The direction of increase of the controlled function shall be indicated

B.2.5 Symbols shall be presented with a high contrast against their background

B.2.6 The various elements of a symbol shall have a fixed ratio one to another

B.2.7 Multiple function of controls and switch positions may be indicated by a combined symbol

B.2.8 Where concentric controls or switches are fitted, the outer of the symbols should refer to the larger diameter control

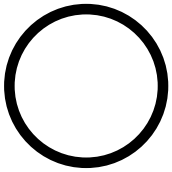
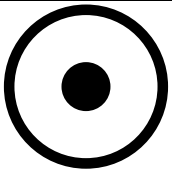
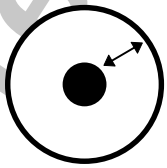
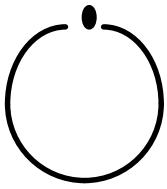
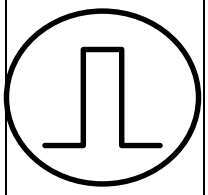
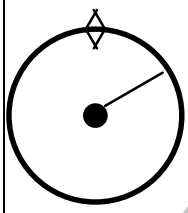
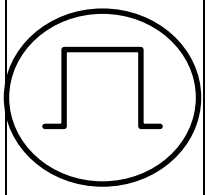
B.3 Symbols

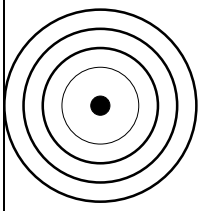
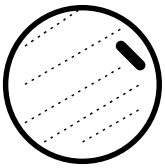
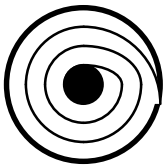
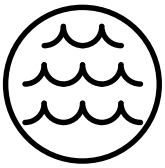
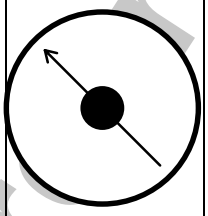
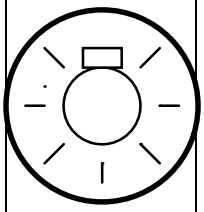
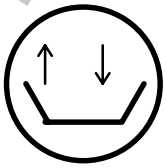
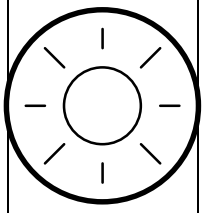
B.3.1 The symbols listed in this clause may be used for controls on marine navigational radar equipment

B.3.2 The circles shown around the following symbols are optional:

.1 Symbol 8: short pulse
.2 Symbol 9: long pulse
.3 Symbol 14: panel illumination
.4 Symbol 19: performance monitor

B.3.3 Symbols for controls on marine navigational radar equipment

	Symbol	Name	Explanation			Symbol	Name	Explanation
1		OFF	To identify the “off” position of the control or switch		6		HEADING LINE OFF	To identify the “heading line” off position
2		ON	To identify the “radar on” position of the switch		7		RANGE	To identify the range selection switch
3		STAND-BY	To identify the “radar stand-by” position of the switch		8		SHORT PULSE	To identify the “short pulse position of the pulse length selection control
4		NORTH-UP	To identify the “north-up ” position of the mode of presentation switch		9		LONG PULSE	To identify the “long” pulse position of the pulse length selection control
5		SHIP’S HEAD-UP	To identify the “ship’s head-up” position of the mode of presentation switch		10		TUNE	To identify the “tuning control”

	Symbol	Name	Explanation			Symbol	Name	Explanation
11		GAIN	To identify the “gain” control		16		RANGE RINGS	To identify the maximum position of the “range rings brilliance” control
12		RAIN	To identify the position of the “rain” control or switch		17		VARIABLE RANGE MARKER	To identify the “variable range marker” control
13		SEA	To identify the minimum position of the “anti-clutter sea” control		18		ELECTRO-NIC BEARING LINE	To identify the “electronic bearing line” control
14		PANEL ILLUMI-NATION	To identify the maximum position of the “scale illumination ” control or switch		19		TRANSMIT /RECEIVE MONITOR	To identify the position of the performanc e monitor switch
15		DISPLAY BRILL-IANCE	To identify the maximum position of the “display brilliance” control					

B.4 Code of practice for standard names and abbreviations

English standard names and abbreviations listed in B.5 are not exhaustive.

B.4.1 Upper case and lower case letters may be used.

B.4.2 Full stops and hyphens shall not be used.

B.4.3 Standard abbreviations can be divided when used in menus, e.g. MAP, SYMBOL, LINE.

B.4.4 New names and abbreviations may be used for new functions provided they do not conflict with B.4.

B.4.5 Names and abbreviations marked with an * are for use in text areas and not in the radar picture area.

B.4.6 It is permissible to use a single first letter abbreviation when unambiguously used with a second abbreviation e.g., T. BRG, L.SPD.

B.4.7 Application

This list is intended to be used on new radar, high speed craft radar and electronic plotting equipment type approved after the revised IMO Resolution A.477 radar performance standard comes into force on 1.1.1999.

B.4.8 Descriptions

The descriptions are not a mandatory glossary, but are given for informative reasons.

B.4.9 Modes

In order to standardise the motion modes of operation the names True motion, Relative motion - true trails and Relative motion - relative trails, are to be used. The standard abbreviation for these modes shall be TM, RM (T) and RM (R).

B.5. Marine radar and high speed craft radar

STANDARD NAMES	STANDARD ABBREVIATIONS	DESCRIPTIONS
ACKNOWLEDGE	ACK	Acknowledge or accept. e.g. Alarm
ADJUST	ADJ	Make changes
ALARM	ALM	Alarm
AUDIBLE	AUD	Audible. e.g. Alarms
AVAILABLE	AVAIL	Available. e.g. Function/sensor available
AUTOMATIC	AUTO	Automatic. e.g. Sea clutter
AZIMUTH	AZI	Azimuth. e.g. Azimuth error, Azimuth stabilised
BACKGROUND	BKGND	Background of display
BEARING	BRG	Bearing
BUILT-IN TEST EQUIPMENT	BITE	Built-in test equipment
CALIBRATE	CAL	Calibrate e.g. radar, performance monitor and touch
CANCEL	CNCL	Cancel e.g. A command or exit
CENTRE	CEN	Centre
*CHANGE	CHG	Change
CIRCULAR POLARISED	CP	Circular polarised. e.g. Antenna
CLEAR	CLR	Clear e.g. remove data, video, synthetics currently entered
COMPASS	COMPASS	Compass e.g. Compass error
CONTRAST	CONTR	Contrast on display
CORRECTION	CORR	Correction
COURSE	CSE	Course e.g. Next course. New course
COURSE OVER THE GROUND	COG	Course made good over the ground e.g. True
COURSE TO STEER	CTS	Course is the direction which a vessel is steering or intended to be steered
COURSE-UP	C UP	Course-up stabilised display mode
CURSOR	CURS	A moveable reference used in reading bearings or a highlighted input point on the screen
DATA	DATA	Data
DATE	DATE	Date
DAY/NIGHT	DAY/NT	Day and night e.g. Background, brilliance
DEAD RECKONING	DR	A position based on true course steered and speed through the water
DECREASE	DECR or -	Decreasing a value
DEGAUSS	DEGAUSS	Degauss the display
DEGREES	DEG or °	Degree. A measure of angle
DELETE	DEL	Delete
DISPLAY	DISP	Display e.g. Radar screen
DISTANCE	DIST	Distance
DRIFT	DRIFT	Distance covered solely due to current, tidal stream and surface drift
ELECTRONIC BEARING LINE	EBL	Electronic bearing line on the display
ELECTRONIC RANGE AND BEARING LINE	ERBL	Electronic range and bearing line
ENHANCE	ENH	Enhance e.g. Video
ENTER	ENT	Enter e.g. Selected data
EQUIPMENT	EQUIP	Equipment
ERROR	ERR	Error e.g. Operator, Alarm
ESTIMATED POSITION	EP	Estimated position. The position derived from DR, leeway and drift
EXTERNAL	EXT	External e.g. Input, Alarm
GROUND STABILISED	GND STAB	Ground stabilised mode
GROUND TRACK	GND TRK	Ground track

GYRO	GYRO	Gyro
HEADING	HDG	Heading. The direction in which the bows of a ship are pointing expressed as an angular displacement from north. From 000 to 360 clockwise
HEADING LINE	HL	Heading line
HOURS	HR	Hours
INCREASE	INCR or +	Increase a value
INFORMATION	INFO	Information
INITIALISATION	INIT	Initialisation e.g. Starting a process or setting up parameters
INTERFERENCE REJECTOR	IR	Interference rejector e.g. Rejection of other ship's radar interference (pulse to pulse correlator)
INTERSWITCH	ISW	Inter-switch function
INPUT	IN	Input
INPUT/ OUTPUT	I/O	Input/output
KNOTS	KT	Knots
*LABEL	LBL	Labels used to identify objects e.g. To manually label a plot or target
LEEWAY	LWY	Leeway is the effect of wind in moving a vessel bodily to leeward at right angle to the course steered
LIMIT	LIM	Limit e.g. The maximum or minimum range of a value
LOG	LOG	Log e.g. Sensor for determining ship's speed
MAGNETIC	MAG	Magnetic
MAGNETIC VARIATION	MAG VAR	Magnetic variation
MANUAL	MAN	Manual. e.g. Acquisition, operation, and system input and "MAN SPD"
MARKER	MKR	Marker
MASTER	MSTR	Master e.g. Display, Radar
MAXIMUM	MAX	Maximum (used before the value)
MEDIUM PULSE	MP	Medium pulse
MENU	MENU	Menu. A list of commands and/or options
MINIMUM	MIN	Minimum (used before the value or in association with MAX)
MINUTES	MIN	Minutes (used after the value)
MISSING	MISSING	Missing. e.g. HL missing
MUTE	MUTE	Mute or silence e.g. Alarm
NAUTICAL MILE	NM	Nautical mile
NORMAL	NORM	Normal
OFFCENTRE	OFF CENT	Off centre e.g. Off centre set or reset
OFFSET	OFFSET	Offset e.g. Where EBL is offset from own ship
OUTPUT	OUT	Output
OWN SHIP	OS	Own ship
PARALLEL INDEX LINE	PI	Parallel index line, referenced to own ship
PERMANENT	PERM	Permanent e.g. Permanent track
PERSONAL ACCESS CODE	PIN	Personal access code e.g. For user settings
POSITION	POSN	Position
POWER	PWR	Power
PULSE LENGTH	PL	Pulse length
PULSES PER REVOLUTION	PPR	Number of pulses during the revolution of antenna
PULSE REPETITION FREQUENCY	PRF	Pulse repetition frequency
RADAR	RDR	Radar
RANGE	RNG	The range e.g. of a target. Not to be used for range scale
RECEIVER	RX	Receiver

RELATIVE	REL	Relative
RELATIVE BEARING	R BRG	Relative bearing; relative to ship's head
RELATIVE COURSE	R CSE	Relative course
RELATIVE MOTION	RM	Relative motion
RM (TRUE TRAILS)	RM (T)	Relative motion with true trails
RM (RELATIVE TRAILS)	RM (R)	Relative motion with relative trails
*SCAN TO SCAN	SC/SC	Scan to scan correlation. A number may be added to indicate the number of correlation scans
SECONDS	SEC	Time in seconds
SELECT	SEL	Select e.g. Menu, Data, Target
SET	SET	The resultant direction towards which current, tidal stream and surface drift flow
SIMULATION	SIM	Simulation
SLAVE	SLAVE	Slave e.g. Display
SPEED	SPD	Speed e.g. In knots
*SPEED OVER THE GROUND	SOG	Speed made good over the ground e.g. from GPS, ECHO REF., Dual axis LOG
SPEED THROUGH THE WATER LOG	STW	Speed made good through the water. e.g. (water track)
STABILISED	STAB	Stabilised
SYNCHRONISATION PULSE	SYNC	Synchronisation
TARGET	TGT	Target e.g. Any fixed or moving object, measured by radar
TIME TO GO	TTG	Time to go
TRAILS	TRAILS	Trails. Synthetic afterglow. True or relative. True trails may be sea or ground stabilised
TRANSCEIVER	TX/RX	Transceiver e.g. X or S TX/RX, TX/RX 1 or 2 etc
TRANSMITTER	TX	Transmitter
TRANSPONDER	TPR	Transponder
TRIGGER PULSE	TRIG	Trigger or timing pulse e.g. Trigger error
TRUE	TRUE	True e.g. True data, true heading
TRUE COURSE	T CSE	True course
TRUE BEARING Compass	T BRG	True bearing. Relative to true north. bearing corrected for compass error
TRUE MOTION	TM	True motion
TRUE SPEED	T SPD	True speed
UNINTERRUPTED POWER SUPPLY	UPS	Uninterrupted power supply
UNSTABILISED	UNSTAB	Unstabilized
VIDEO	VID	Video
VISUAL DISPLAY UNIT	VDU	Visual display unit
VIDEO NORMAL	VID NORM	Video normal
*X-BAND	X	X-band (3 cm wavelength) e.g. Transceiver
*S-BAND	S	S-band(10 cm wavelength) e.g. Transceiver

B.6 ARPA, ATA and EPA

STANDARD NAMES	STANDARD ABBREVIATIONS	DESCRIPTIONS
ACQUIRE	ACQ	Acquisition. The process of selecting a target and initiating tracking or plotting
ACQUISITION ZONE	AZ	Acquisition zone. A zone where targets will be automatically acquired e.g. Footprint-FAZ, Sector-SECT AZ and Inclusion zone-INC AZ
ANCHOR WATCH	ANCH	Anchor watch
AUTOMATIC RADAR PLOTTING AID	ARPA	Automatic radar plotting aid
AUTOMATIC TRACKING AID	ATA	Automatic tracking aid
BOW CROSSING RANGE	BCR	The range at which a target will cross own ship's bow
BOW CROSSING TIME	BCT	The time to BCR
CLOSEST POINT OF APPROACH	CPA	The closest point of approach e.g. Limit (CPA LIM), Trial (CPA T)
DELAY	DELAY	Delay e.g. Setting time to start of manoeuvre
ECHO REFERENCE	REF	Echo reference e.g.. A tracked target used a reference for ground stabilisation
ECHO REFERENCE SPEED	REF SOG	Speed derived from a stationary tracked target
ELECTRONIC PLOTTING AID	EPA	Electronic plotting aid
EXCLUSION ZONE	EZ	Exclusion zone. Zone within an acquisition zone where target will not be acquired automatically
FULL	FULL	Full e.g. Guard zone, Acquisition zone, and tracking has no more capacity
GUARD ZONE	GZ	Guard zone. A zone where an alarm will be given when a target enters it
IDENTIFICATION	ID	Identification e.g. Number of a target in tracking or plotting
LABEL TARGET	LAB TGT	Label target e.g. Display target ID on screen
LOST TARGET	LOST TGT	Lost target e.g. No longer being tracked having been lost and does not have tracking ability
MANOEUVRE TIME	MVR TIME	Manoeuvre time e.g. An alarm indicating manoeuvre should be carried out now
PAST POSITIONS	PAST POSN	Past positions e.g. History dots
PREDICTED AREA OF DANGER	PAD	A graphic showing a PAD around a predicted close quarter situation area
PREDICTED POINT OF COLLISION	PPC	A graphic showing where PPC intercept points lie with respect to own ship and other targets
RELATIVE VECTOR	R VECT	Relative vector
SYMBOLS OFF	SYM OFF	Symbols off. e.g. ARPA, ATA, EPA, NAV, ENC etc
TEST TARGET	TEST TGT	Test target for integrity checking of tracking
TIME TO CLOSEST POINT OF APPROACH	TCPA	Time to closest point of approach. e.g. Limit-TCPA LIM, Trial-TCPA T

TIME TO GO	TTG	Time to go
TRACKING	TRKG	Tracking. The computer process of observing the sequential changes in the position of a target in order to establish its motion
TRIAL MANOEUVRE	TRIAL	Trial manoeuvre. T is the ARPA symbol
TRUE VECTOR	T VECT	True vector
VECTOR	VECT	Vector e.g. True or relative
VECTOR TIME	VECT TIME	Vector time e.g. Length of vector measured in units of time

B.7 Geographics, mapping and navigation

STANDARD NAMES	STANDARD ABBREVIATION	DESCRIPTIONS
ANTENNA	ANT	Antenna e.g. Radar or GPS
AUTOPILOT	AP	Auto-pilot. An automatic heading control aid to enable a vessel to maintain its heading in an intended direction
BEARING AND DISTANCE TO WAYPOINT	BWC	Bearing and distance to way-point (great circle)
BEARING AND DISTANCE TO WAYPOINT	BWR	Bearing and distance to way-point (rhumb line)
BEARING ORIGIN TO DESTINATION	BOD	Bearing origin to destination
BEARING WAYPOINT TO WAYPOINT	BWW	Bearing way-point to way-point
CO-ORDINATED UNIVERSAL TIME	UTC	Co-ordinated universal time
CROSS TRACK ERROR	XTE	Cross track error
CURVED HEADING LINE	CHL	Curved heading line for showing predicted track
DGPS	DGPS	Differential GPS. Local-L or Wide-W area system
DECCA	DEC	Decca navigator
DEPTH	DPTH	Depth e.g. Depth alarm
DESTINATION	DEST	Destination
DISTANCE INTERVAL	DIST INT	Distance interval between tracked positions of targets
ECDIS	ECDIS	Electronic chart display and information system
ELECTRONIC NAVIGATIONAL CHART	ENC	The data base held on board the ship for use with ECDIS
ELECTRONIC POSITION-FIXING SYSTEM	EPFS	Electronic position-fixing systems. e.g. GPS, DECCA, LORAN-C
ESTIMATED TIME OF ARRIVAL	ETA	Estimated time of arrival
EVENT	EVENT	Event on radar or ECDIS
GLOBAL POSITIONING SYSTEM	GPS	GPS
GLONASS	GLO	GLONASS

GEOGRAPHICS	GEOG	Geographics. Maps and grid elements
GREAT CIRCLE	GC	Great Circle
GRID	GRID	Latitude and longitude grid, the lines of which approximate to a Mercator projection
HEADING CONTROL SYSTEM	HCS	Heading control system
INFRARED	INF RED	Infrared e.g. sensor
INTEGRATED BRIDGE SYSTEM	IBS	Integrated bridge system
INTEGRATED NAVIGATION SYSTEM	INS	Integrated navigation system
INTEGRATED RADIO COMMUNICATION SYSTEM	IRCS	Integrated radio communication system
LATITUDE	LAT	Latitude
LATITUDE/LONGITUDE	L/L	Latitude/Longitude
LINE OF POSITION	LOP	Line of position
LONGITUDE	LON	Longitude
LORAN	LOR	Loran-C'
MAN OVERBOARD	MOB	Man overboard
MAP LINES	MAP LINES	Map lines. A navigational facility defining channels or traffic separation schemes which are ground stabilised
MAPS	MAP	Maps generated by the user
NAVIGATION	NAV	Navigation e.g. “NAV SOG” from an EPFS
OFF TRACK	OFF TRK	Off track e.g. Off track alarm
POSITION	POSN	Position e.g. Mode select, Display
RADAR SYSTEM DATA	RSD	Radar system data
RADIUS	RAD	Radius turn e.g. NEXT RAD
RATE OF TURN	ROT	Rate of turn
RHUMB LINE	RHL	Sailing on a constant course
ROUTE	RTE	Route. A planned course of travel, usually composed of more than one leg
SAFETY CONTOUR	SAF CON	Safety contour for depth e.g. From ECDIS
SEQUENCE	SEQ	Sequence e.g. Maps
SYSTEM ELECTRONIC NAVIGATIONAL CHART	SENC	System electronic navigational chart
TRACK	TRK	The path followed or to be followed from one position to another
TRACK CONTROL SYSTEM	TCS	Track control system
TRACK MADE GOOD	TMG	Track made good between the point of departure to a point of arrival
TRACK PILOT	TRK P	Track pilot
VOYAGE	VOY	Voyage e.g. Voyage
WAYPOINT	WPT	Way-point. A reference point on the track
WAYPOINT CLOSURE VELOCITY	WCV	Way-point closure velocity
WHEEL OVER POINT	WOP	Wheel over point or line
WORLD GEODETIC SYSTEM	WGS	World geodetic system e.g. WGS 84

Annex C
(normative)

Guidelines for the display of navigational information on radar by means of radar maps

C.1 Definitions

C.1.1 Guidelines

This guideline, as far as possible, quantifies solutions for type approval, but does not exclude the application of alternative solutions provided the functional requirements are met. This guideline will be amended when technical developments or operational experience form a basis for a better solution.

C.1.2 Radar map

A radar map is a combination of map lines and symbols whereby the user can define and input the navigation, route planning and monitoring data on the radar equipment.

C.2 Application

C.2.1 Radar maps may be displayed in such a way that the primary radar and electronic plotting (ARPA, ATA and EPA) information is clearly visible.

C.2.2 Radar maps may be displayed on multi-colour and monochrome displays.

C.2.3 Radar maps displayed on multi-colour displays shall conform as far as is practicable to the following principles :-

C.2.3.1 The map information displayed is limited to items in C.4;

C.2.3.2 The map symbols used to display the information in C.2.3.1 are similar in shape to those defined in appendix 2 of IHO S-52 figure 1- items 1 to 40;

C.2.3.3 The map colours used to display the information in C.2.3.1 are listed in C.4. Where these are not automatically selected, the operating manual shall clearly show how this is to be achieved.

C.2.4 Radar maps displayed on monochrome displays shall conform as far as is practicable to the following principles :

C.2.4.1 Those in C.2.3.1 and C.2.3.2.

C.2.4.2 Other means than colour may be used to differentiate lines.

C.2.5 Radar map colour fill may be displayed where appropriate in such a way that the primary radar and electronic plotting information is clearly visible.

C.3 Navigation symbols for use with radar maps

C.3.1 Navigation symbols for use with radar maps shall be similar to those used for the chart radar.(see E.5)

C.3.2 The number of types of navigational symbols used shall be limited to provide simple operation. The minimum types of symbols normally available for use are symbols 1.1, 1.2, 5, 6, 11, 12 and 13, but the use of any symbols 1 to 16 is permitted.

C.3.3 The shape of these navigational symbols used on multi-colour and monochrome displays shall be similar to those used for the chart radar.

C.3.4 The use and selection of colours for these symbols and other non-standard navigational symbols not in C.5 is optional. For planned routes, red, as used in the ECDIS, is recommended.

C.4 Features and colours to be used for radar maps

Mapping feature	Colour to be used
Coastline (high water)	White
Own ship safety contour	Grey
Indication of isolated underwater dangers of depths less than the safety contour which lie within the safe water defined by the safety contour.	Magenta
Indication of isolated dangers which lie within the safe water defined by the safety contour such as bridges, overhead wires etc.	Magenta or grey
Buoys and beacons whether or not these are being used as aids to navigation.	Red or green
Traffic routeing systems.	Magenta
Prohibited and restricted areas.	Magenta
Boundaries of fairways and channels.	Grey
Radar background.	Black or blue

C.4.1 When the “own ship safety contour” feature is used, the dangerous side shall be clearly indicated, for example, by colour fill, hatching, double lines, broken line etc., on the dangerous side.

C.5 Navigational symbols for radar with chart facilities - (also used on radar maps)

C.5.1 Introduction

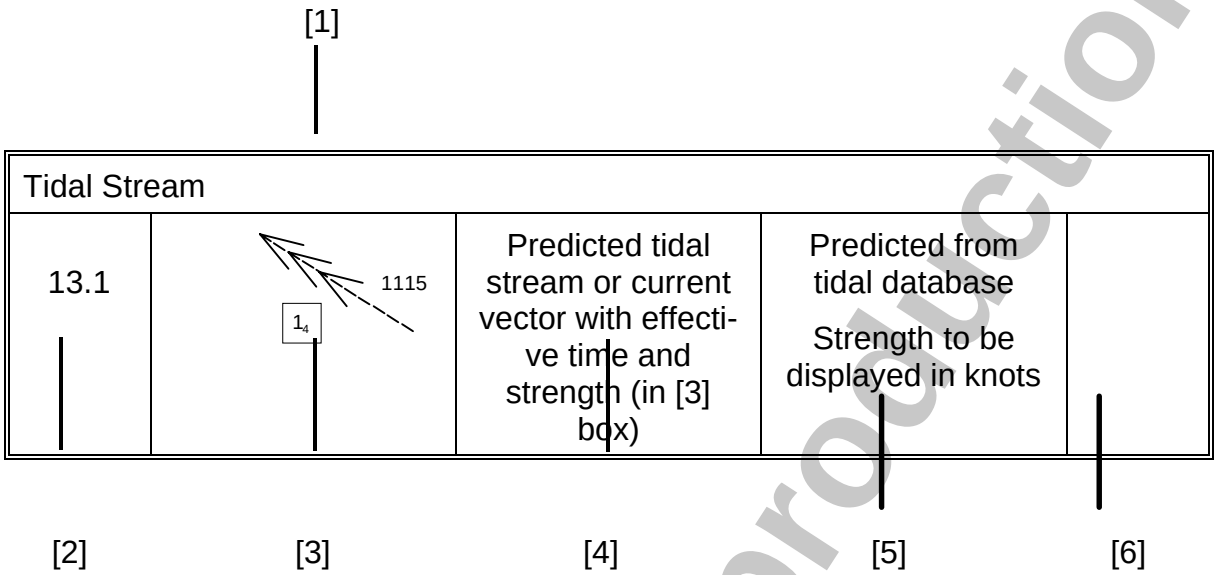
This provides a definition of the navigational symbols to be used on the colour radar (that can also be used on radar maps). These symbols are for use to display navigational information on radars displaying selected parts of the ECDIS SENC.
It has been developed to harmonise the navigational and chart symbols used on the radar with those used on the ECDIS (IEC 61174) and for electronic plotting (IEC 60872-2) on high speed craft (HSC).

C.5.2 Symbols

The following provides information to aid the understanding of the details of the symbols and format:

.1 Symbols 1 - 7 cover route monitoring and symbols 8 - 16 provide route planning facilities;
.2 Symbols 5 and 6 provide an emulation of paper chart position plotting facilities;
.3 The facilities provided by symbols 13 and 14 may be replaced by more direct means;
.4 Target reporting symbols 2.3, 2.4 and 2.5 shall be in a different colour to target plotting symbols 2.6, 2.7 and 2.8. The display of symbols 2.3, 2.4 and 2.5 are optional, but if used shall be capable of being removed from the display;
.5 Additional symbols may be used for other navigational purposes provided that they do not conflict with the ECDIS navigational and chart symbols or radar electronic plotting symbols;
.6 Alphanumeric labels and symbols are to be of a size such that they are clearly legible;
.7 All navigational symbol sizes relate to the minimum ECDIS screen size of 270 mm (see IEC 61174) and may be appropriately scaled for the different radar screen sizes.

C.5.2.1 Symbol definition format



[1] Section

[2] Sub-section number

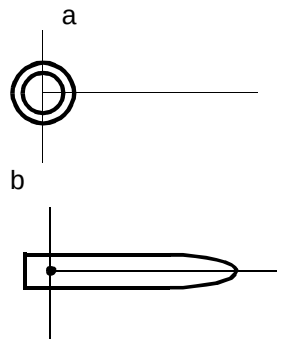
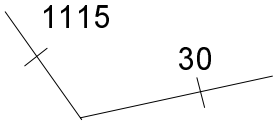
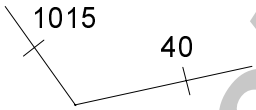
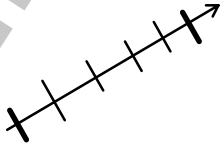
[3] Symbol to be used on radar with chart facilities

[4] Description in the English language

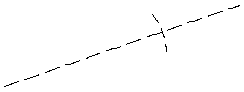
[5] Notes

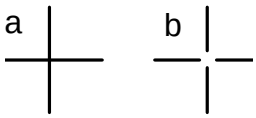
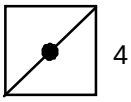
[6] The radar with chart facilities does not use this field, but it is used by ECDIS for the colour token

C.5.2.2 Route monitoring and route planning symbols

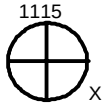
Route monitoring - position lines				
1		Own ship	The use of symbol 1-a/b on radar systems is optional. Symbol 'b' must be scaled to indicate length and beam of the vessel and may be representative of own ship's outline. In either case the largest dimension of the symbol shall not be less than 6 mm. Heading and beam lines are optional. If displayed, heading line extends to chart window edge and beam line extends 10 mm (optionally extendable).	ships
1.1		Past track with time marks for primary track	Time mark intervals may be set by the operator. Time to be HHMM or MM.	pstrk
1.2		Past track with time marks for secondary track	Time mark intervals may be set by the operator. Time to be HHMM or MM.	sytrk
2.1		Own ship's vector for course and speed made good (i.e. over ground)	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships
2.2		Own ship's vector for course and speed through water	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships

Target tracking - AIS reported targets				
2.3		"Active" AIS target	Centre is pivot point. Orientated with heading. Heading line is 25 mm long.	arpat
2.4		"Sleeping" AIS target To avoid confusion with AIS target with no associated vector.	Centre is pivot point. Orientated with heading. "Sleeping" AIS has no vector.	arpat
2.5		Vector for course and speed made good (i.e. over ground).	Marks at 1 min intervals. Filled mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	arpat
Electronic plotting video symbols - IEC 60872				
2.6	See IEC 60872	Plotted target - Course and speed vector IEC 60872 video symbol 4A		arpat
2.7	See IEC 60872	Vector for course and speed made good (i.e. over ground). IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	ships
2.8	See IEC 60872	Vector for course and speed through water. IEC 60872 video symbol 4B	Marks at 1 min intervals. Thick mark at 6 min intervals. Length represents user selected period applied to ALL vectors.	Ships

Route monitoring - position lines				
3		Variable range marker and/or electronic bearing line	The VRM and EBL may be ship centred or freely movable. A small filled circle indicates the EBL origin when offset. An EBL is to be an interrupted line with long dashes. The first VRM is to be a long dashed ring. The second VRM is to be a long dashed ring distinguished by a different line style of dashes.	ninfo

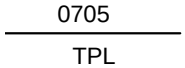
Route monitoring - general				
4		Cursor	The cursor crossover point may be left blank as shown in 'b'. In either case the largest dimension of the symbol shall not be less than 10 mm.	cursr
5		Event	The symbol may be numbered and have additional text such as time / "MOB" associated with it.	ninfo
All own ship references relate to the conning position				

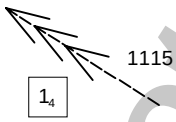
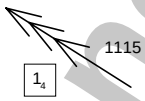
Route monitoring - calculated positions (indicated by thickened circle)				
5.1		Dead reckoning position and time (DR)		ninfo
5.2		Estimated position and time (EP)		ninfo

Route monitoring - position fixes				
6		Fix and time	X indicates method of fix	ninfo

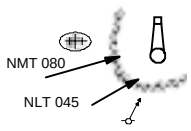
V	Visual	Gl	Glonass
A	Astronomical	L	Loran / Tchaika
R	Radar	M	MFDF
D	Decca	O	Omega
G	GPS	T	Transit / Tsikada

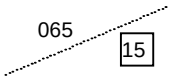
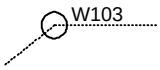
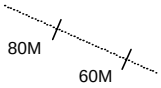
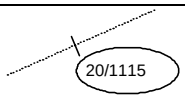
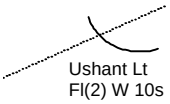
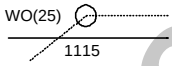
A differential system is denoted by a prefix ´d´, e.g. dG, dO etc.

Route monitoring - position lines				
7		Position line and time		ninfo
8		Transferred position line and time		ninfo

Route planning - tidal stream				
8.1		Predicted tidal stream or current vector with effective time and strength (in box)	Predicted from tidal database	ninfo
8.2		Actual tidal stream or current vector with effective time and strength (in box)	Measured from available sensor information. Strength to be displayed in knots	ninfo

Route planning - danger highlight				
9		Danger highlight	Transparent red danger arcs drawn by the operator. May be flashing. Examples shown are wrecks. All underlying chart data shall be clearly visible.	dnghl

Route planning - clearing lines				
10		Clearing line NMT=Not more than NLT=Not less than	Example is shown for clearing a wreck and north mark buoy	ninfo

Route Monitoring - Calculated positions (indicated by thickened circle)				
11		Planned course and speed to make good. Speed is shown in box.		plrte/aplrt
12		Waypoint (Used in conjunction with symbols 14 and 19)	Waypoints may be labelled. Label shall be unique. First character shall be a letter but not ´O´, ´I´ or ´Z´	plrte/aplrt
13		Distance to run	May be replaced by more direct means	plrte/aplrt
14		Planned position with date and time.	May be replaced by more direct means	plrte/aplrt
15		Visual limits of lights, arc to shore rising/dipping range	Inscriptions are optional NOTE - not shown on alternate route	ninfo
16		Estimated position and time (EP). Position and time of “wheel-over” *	Minimum symbol to indicate “wheel-over” line (annotated ´WO´), other data can be optionally provided. NOTE - not shown on alternate route	ninfo

- - “wheel-over” is defined as a geographic position along the ship’s intended track where, taking into account the dynamics of the ship and the prevailing environmental conditions, the mariner considers it necessary to put the “wheel-over” to achieve the intended new track.

ANNEX D
(normative)

Measurement methods for spurious emissions

D.1 Introduction

The ITU-R recommendation M.1177 contains measurement methods for spurious emissions. It is currently being updated to also include methods for the measurement of out-of-band emissions. The recommendation contains two methods, the “direct” and “indirect”.

In simple terms the direct method involves the use of a mobile measuring system that allows the measurements to be made at the practical location of the radar under test. The measurements would be made in the “far-field” of the radar system and would be independent of any “ground” reflections.

The indirect method uses a fixed facility which allows separate measurement of the radar antenna and the other sub-systems of the radar system. The recommendation contains details of how the attenuation characteristics of various parts of the system are summed in order to give an overall system value of the spurious emission level relative to the carrier power as a function of frequency.

The Appendix S3 of the Radio Regulations states that the frequency range of application of the permitted levels extends to 110 GHz. In practice the frequency cut-off of the the radar system waveguide will be much lower.

A practical upper limit of 18 GHz has been chosen for measurement of shipborne radars. This takes into account the availability and cost of test equipment that would be suitable for the radars covered by this standard.

D.2 Methods of measurement

The methods of measurement contained in ITU RM. 1177 have been used to evaluate the spurious emission levels of some shipborne radars, in particular, using the indirect method.
As experience is gained, those methods will be amplified to provide more detailed guidance, and will be developed as a revision to this standard.
For the purposes of this standard, either method contained in ITU-RM.1177 is admissible.

D.3 Results required

Spurious emission levels shall be at least 43 + 10 log PEP or 60 dB, whichever is the less stringent, below the carrier power, as measured in the far-field of the radar, for all frequencies up to 18 GHz. [1]

[1] With regard to the Radio Regulations, the application of these limits is for new radars installed after 1 January, 2003.